

PAPAYA DISEASES

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The growing of papayas has been tried in many Florida localities with varying degrees of success. The papaya is a succulent and strictly tropical plant which will not endure the low temperatures that some of the other tropical and sub-tropical plants grown here can ordinarily withstand. It will thrive best in localities where freezing temperatures and cool weather are of rare occurrence and of short duration, which limits its successful production to the southern part of the State or to unusually well protected areas in other parts of the State.

Temperatures considerably above freezing will slow down the activity of the plant and extended cool periods materially affect the quality of fruits ripening under such conditions.

The papaya is not only affected by adverse temperature and moisture conditions but it is also affected by certain diseases, which form an extending list and about which we are learning more as time goes on. The purpose of this paper is to present the more serious diseases that have been reported on the papaya, and especially those that are known to occur in Florida, some of which we have had under study during the past few years.

PAPAYA LEAF BLIGHT

Pucciniopsis caricae. Earle

Leaf blight, leaf spot or black rust, as it is sometimes called, has been in Florida for a number of years, and it is widely distributed in most of the localities where the papaya is generally grown. It is probably the most serious disease of the bearing plant under Florida conditions, causing destruction of the foliage, low vitality of the plant, and a reduced and inferior crop of fruits. Attacks of the disease are usually confined to the leaves, but under certain conditions, maturing fruits may become badly affected. This condition was very noticeable

during the spring of 1937 and a dozen or more varieties in our experimental plots bore fruits that were distinctly affected with the disease. However, the trouble is considered primarily a leaf disease and one that causes a rapid destruction of leaf tissue, hence the name blight.

Leaf blight is a fungus disease caused by *Pucciniopsis caricae*. Earle. Specimens from which the fungus was identified and named were collected at Sanibel Island, Florida, in 1901¹. The disease was again noted at St. Cloud, Florida, in 1920. It occurs in Puerto Rico^{2,4} where it is considered a serious pest, and it is also present in Cuba³ and British Guiana⁵.

APPEARANCE

Papaya leaf blight is easily recognized by the black pustular spots that appear on the under surfaces of infected leaves. The effect is very suggestive of that produced by many of the true rusts on other plants. The infected areas are small, generally circular in outline, and slightly raised above the leaf tissue. Their surfaces are covered with a black, powdery mass of spores by means of which the disease may be rapidly carried to other parts of the plant or to neighboring plants. Primary infections are usually scattered and they may vary from one-eighth of an inch to mere dots in size. As spore production continues, other spots appear and the under side of the leaf soon becomes thickly studded with the black pustular masses. On the upper side of affected leaves, the infections appear as small brown spots of dead tissue, distinctly outlined on the leaf surface. No spore production occurs on the surfaces of these spots.

On fruits, the black pustular type of spot occurs similar to those on the under surface of the leaves. Such spots are slightly larger and may be numerous or scattered, depending on the severity of the attack. Spores develop readily in

spots on the fruits and they are active sources in spreading the disease. The infections on fruits do not penetrate deep into the rind and no decay is caused by the fungus. The injury to fruits is confined chiefly to a marred, or spotted surface.

The general effect of the disease on the plant is soon evident in a loss of vigor and foliage. Severe attacks on leaves may cause extensive defoliation, or the attack may cause sufficient destruction of leaf tissue as to weaken the plant beyond the point where it is capable of properly maturing the crop. As a result, smaller fruits are produced, of inferior quality.

For the past three seasons, we have had the opportunity to observe the effects of the disease on several different papaya varieties. All edible varieties are more or less susceptible, and the severity of the disease will vary according to the season in which it occurs. Individual plants of the same variety vary greatly in susceptibility from one season to another. No promising edible variety has yet been observed showing complete immunity to the disease, and the only papaya plants we have observed on which the disease has appeared is a closely related species, *Carica quercifolia*, a mountain type which does not produce edible fruits. This plant, however, may be valuable in breeding up varieties highly resistant or immune.

CAUSE AND DISSEMINATION OF THE DISEASE

As previously stated, leaf blight is caused by the fungus *Pucciniopsis caricae*. This fungus belongs to a group of fungi, the members of which still have an undetermined position in the natural classification of fungi. Only one form of the fungus is known at present and very little has been learned of its life history or relation to host. The fungus cannot be isolated and grown on artificial media in the laboratory and studied like most of the disease-producing organisms; hence our studies have been confined to the development of the organism on the living plants. Through inoculations on healthy leaves of small papaya plants, we have found that infections occur under moist conditions in from 24 to 48 hours. Visible effects of the fungus on the inoculated leaf tissue are seen in eight to ten days after inoculations.

These appear as small greenish water-soaked areas, which later develop into the typical spots of the disease. Spores were produced, always on the under side of the leaf, in eighteen to twenty-one days after the inoculations were made. Inoculations were made simultaneously in marked areas on the upper and under sides of the same leaf, but infections only resulted where the spores were applied to the under surface of the leaf and kept in a moist state for 24 to 36 hours.

It was also noted that infections only occurred on leaves that had reached a certain stage of growth. Attacks were confined to the older leaves of the plant and the young developing leaves were apparently immune or not attacked until the leaf had fully expanded and the tissue had become firm. A few scattering spots may appear on a susceptible leaf, usually near the edges. These bear spores and in three to four weeks later other small spots appear, surrounding the original spots. These also bear spores and the process is continued until the entire lower surface of the leaf is affected. When the leaf becomes severely infected, the leaf tissue ceases to function, becoming brown and dead, and finally drops from the plant. Severely affected plants may lose from 50 to 60 per cent of their more mature leaves in a period of two or three months.

The disease is probably spread over long distances by wind and insects. It is easily spread over individual plants by rains, fogs, and heavy dews, when once established on the plant.

The stem of the papaya, leaf petioles, flowers, and young fruits are apparently immune to infection since we have never observed infections on any of these parts. Infections occur on mature fruits but not regularly. Infected fruits have been observed only during two seasons, and the infections range from slight to severe in practically all of the different varieties we had in our collections those years.

The disease appears to be seasonal in its habit of appearance and it is generally more active during the winter and spring seasons. Perhaps the vitality of the plant is lower at this period and it is more easily affected by the disease. Plants that are set in the open in early spring usually go through the summer and early winter

without any indication of the disease. Through December and January the disease may begin to appear and it reaches its peak sometime in February or March, if control measures are not employed. Plants that are carried over for the second year may retain the disease on old infected leaves which will continue to give serious trouble until it is brought under control.

CONTROL

No definite spray schedule has yet been worked out for the papaya plant and very few field sprayings have been made for the control of papaya diseases. The leaf blight can be kept under sufficient control if precautions are taken in time. Remedial measures are necessary where large bearing plants are concerned, as soon as the disease appears on the leaves.

All leaves showing infections should be removed and destroyed. These will usually be the lower and older leaves on the plant. The infected plants should be well sprayed, taking care to cover the under sides of the leaves with an even coating of bordeaux mixture. A 3-3-50 bordeaux mixture will be sufficiently effective if applied thoroughly and at frequent intervals. Applications made at two or three-week intervals should control the disease where the infected leaves are kept removed, and three or four applications of the spray should clean up any moderate infection.

It will not be necessary to spray the topmost leaves of the plant since they are not subject to infection until they have fully expanded and the tissue has hardened. The young, tender leaves are frequently subject to severe burn from bordeaux mixture, even in the most dilute forms, and considerable injury may occur where the bordeaux is used on this type of growth. By spraying the mature older leaves on the under surfaces, a good coverage can be obtained on the leaf surface needing protection, without covering the top of the plant.

If the disease is kept from the leaves, there will be slight danger of it appearing on the fruits. With bearing plants, it will be impossible to spray the leaves without spraying the fruits also. This may cause a temporary stain on the fruits that can easily be removed by washing after the fruits are picked.

Leaf blight is more apt to give trouble through the winter season and a close watch should be kept for it in late fall. As soon as the disease appears, it should be taken care of. One or two spray applications made when the disease first appears may accomplish more in the way of control than a half dozen applications made after the disease becomes well established.

POWDERY MILDEW

Oidium sp.

Powdery mildew is another disease that attacks the leaves of the papaya plant. It is also a cool-weather disease and frequently occurs in association with leaf blight. The disease is more rapid in its action than leaf blight and severe attacks quickly destroy the affected leaves causing them to turn brown, die and drop. It attacks the leaves of mature bearing plants and it may give trouble on young seedling plants in the seed beds. It is common in many sections where the papaya is grown, but the trouble can be easily prevented by a few applications of sulphur dust.

APPEARANCE

On the matured leaves of bearing plants, the disease first appears as roundish irregular spots, or blotches, half an inch or so in diameter. Viewed from the upper surface of the leaf, the spots appear greenish yellow in outline with a brownish central portion. The under surfaces of spots are of darker green color, the affected tissue having a water-soaked appearance. A white cobwebby growth soon appears over both surfaces of the spots and this becomes covered with a white powdery growth of fungus spores, hence the name powdery mildew. The spots may increase in size to an inch or more in diameter or several may unite to form irregular patches. Severely infected leaves soon become yellow, the tissue dies and the leaves drop. On the mature leaves of younger plants the spots are not so definite and the disease appears as irregular patches of white powdery growth on both surfaces of the leaves. The fungus continues to spread in this manner until most of the leaf surface is covered by the white powdery growth. In this condition, the leaf soon dies.

No definite cases of mildew have yet been observed on papaya fruit in Florida. It is reported as slightly affecting young fruits in Queensland, Australia.

The disease is caused by a fungus belonging to the *Oidium* group and it is probably *Oidium caricae* which has been described as attacking the papaya.

The fungus apparently does not attack the papaya tissue until it has reached a certain stage of growth, and its attacks are confined chiefly to fully developed leaf tissue. The disease has not been observed on the bloom, young fruits, or the young immature leaves, even in cases where the older leaves of an affected plant were severely infected with mildew. Infected plants have been kept under observation for a period of several months, and leaves in various stages of growth have been selected and observed at definite intervals during this time and it was found that infection did not occur until after the leaf had fully expanded and the leaf tissue had become more or less firm or hardened.

Very little is known about the life history of this fungus and its method of dissemination. It is another one of those organisms that cannot be grown and studied under laboratory conditions. It is undoubtedly spread by wind and insects and requires a cool, moist temperature for its most destructive work. During the summer period it rapidly disappears.

CONTROL

The disease need not be a serious factor to papaya growing since it yields readily to sulphur dust. Two or three thorough applications of good dusting sulphur should control any ordinary attack. As soon as the mildew appears, dust the infected plants. Severely infected leaves should be removed and destroyed. The dust may be applied at 10-day intervals until the disease has disappeared.

DAMPING OFF OF PAPAYA SEEDLINGS

Rhizoctonia sp.

Young papaya plants are frequently killed by Damping Off, a disease confined chiefly to the seed bed. The disease is caused by a fungus

present in the soil which attacks the young plants shortly after they have pushed through the ground. The stem of the plant, usually at or just above the surface of the soil, is penetrated by the fungus. The affected stem first becomes watery, finally shrinks or contracts at the point of infection, and the plant falls to the ground and soon decays.

The disease may appear in one or two spots in the bed or flat where the seeds are sprouted and soon spread over the entire area. Very little can be done in the way of control after the disease appears in a seed bed. Since the disease is carried in the soil, it is important to properly prepare the seedbed before the seeds are planted.

We have found a species of *Rhizoctonia* which has repeatedly caused trouble in many of our plantings of papaya seeds the past few years. *Rhizoctonia* is a common soil fungus that attacks a number of plants and it probably occurs naturally in many of the cultivated areas in Florida. The fungus apparently attacks the young plants the first few days after the seeds have germinated. Excessive moisture and a waterlogged condition of the seed bed soil favors a rapid spread of the fungus. The disease is not carried on or in the seeds and seed treatment will not prevent the trouble.

CONTROL

The most effective way of avoiding Damping Off is to use sterilized soil for the seed beds. Steam is the most effective sterilizing agent where it can be used. For small plots or small beds, chemical treatments may be used to better advantage, and a formaldehyde solution will give satisfactory results. The soil may be treated in plots, boxes, or in the open. Formaldehyde is easily obtained locally and the commercial product should be diluted one part in 50 of water before using. From one gallon to one and one-half gallons of the diluted solution should be applied to each square foot of surface soil to be treated. The liquid is applied with a sprinkling can and should be evenly distributed over the area treated. After sprinkling, the soil surface should be covered with boards or canvas for twelve or more hours to retain the fumes. The seeds should not

be planted in the treated soil until two weeks after treatment.

FRUIT ROT

Colletotrichum sp.

Certain decays affect the papaya fruits after they are fully ripe or after they are removed from the plant and held for a time. Anthracnose, or ripe rot, is a familiar decay of papaya fruits in Florida and it is generally the result of attacks from a species of *Colletotrichum*. This fungus is apparently different from *Colletotrichum gloeosporioides*, Penz., which causes anthracnose, or ripe rot, on a wide variety of other tropical and sub-tropical fruits. The fungus is widely distributed in the localities where papayas are grown. It is a weak parasite, constantly found associated with dead papaya tissue.

APPEARANCE

The disease appears as sunken spots, or pits, on the surface of the fruit, varying from one-quarter of an inch to an inch or more in diameter. The centers of the sunken areas soon become black, and later pink when spore masses appear in abundance. The flesh beneath the spots continues to decay, becoming soft and watery, and the spots increase in size until the entire fruit is involved.

Frequently the decay will begin around the stem end of the fruit and gradually penetrate into the interior, causing a rot which soon renders the fruit worthless. The tissue around the stem end of the fruit become sunken, black, and later covered with pink spore masses. Fruits that are allowed to remain on the plant until fully ripe or highly colored will contract decay more readily than those that are picked sooner and allowed to color afterward.

The latex test has been found to be a very satisfactory method for determining when the papaya fruit can be picked sufficiently mature to ripen properly after harvesting, though still green in color. The test^a is as follows: Prick the rind of the fruit that is to be tested. If the juice is white and drops readily, the fruit is immature and should not be gathered. If, however, the juice that exudes is clear and viscid, or translucent, the fruit can be considered mature enough to pick.

A large percent of the decay from fruit rots can be avoided by picking the fruit sufficiently early after it comes to maturity. After the fruit becomes fully ripe the rind is much more susceptible to attacks of the fungus, and fruits that are allowed to color on the plant are more exposed to infection and almost invariably develop rots sooner or later.

A satisfactory method of treating papaya fruits after they are picked to prevent decay has not appeared yet, but may later come when the fruits enter more into commercial shipments.

CONTROL

As a means of control, the following suggestions are offered:

Pick the fruit as soon as it is properly mature.

Do not let fruits become yellow or fully ripe on the plant.

Remove all dead leaves and leaf stems and dead papaya tissue from the vicinity of bearing plants.

Infected fruits should be removed from the plants as soon as noticed.

FOREIGN DISEASES

Papaya diseases are troublesome in other parts of the world, and J. H. Simmonds^a senior research officer, Department of Agriculture and Stock, Queensland, Australia, has listed and described several troubles of a serious nature that affect papaya growing in Queensland. Apparently but few of these are common to Florida, or they have not been recognized as such up to the present. A brief summary of the more important diseases of this list may be desirable to assist in their identity if they should ever happen to come our way.

The diseases listed by Mr. Simmonds are as follows:

Black Spot: A disease of all parts of the plant above ground caused by the fungus *Ascochyta caricae*. Widely distributed and serious.

Powdery Mildew: Of fungus origin, caused by a species of *Sphaerotheca*. Attacks are confined to the younger parts of the plant; the leaves and young fruits are affected. Listed as a winter or cold-weather trouble, disappearing when warm weather appears.

Ripe Rots: Fungus diseases affecting fruits, caused by *Ascochyta caricae* and *Gloeosporium* sp. Somewhat similar to the Anthracnose rot of fruits in Florida.

Watery Rot: Fungus decay of fully ripe fruit, caused by *Rhizopus nigricans*. Not important.

Foot Rot: A fungus disease caused by *Pythium ultimum*, attacking the collar and roots of the plant at the ground level. Serious under certain conditions.

Yellow Crinkle: Thought to be a virus disease. Not widespread but considered serious.

Die Back: Cause not known. Probably mal-nutritional. Yellowing and decline of affected plants, predisposed by periods of drought or hot drying winds.

OTHER PAPAYA TROUBLES

In addition to the diseases mentioned, other factors interfere with the normal production of papayas in Florida. Low temperatures, lack of moisture, excessive moisture, and nematode attacks often affect the plant and the quality of the fruit produced.

LOW TEMPERATURES

The papaya plant will make very slow growth at temperatures below 60°, and much below this point the flowering, setting of fruits, and maturing of fruits is slowed down materially. Freezing temperature for short periods will injure the foliage and top of the plant and a few degrees below freezing may kill the plant to the ground. Even where heat has been used at night to prevent the foliage from freezing, the low temperatures cause an apparent shock to the plant from which it does not recover for a considerable period of time. Fruit matures slowly under these conditions, and the fruit that does mature is of poor quality and often flat, or insipid in flavor. Thus, for best results, papayas should be grown in well-protected areas where they will be able to go through the ordinary winter without the need of protection from cold. One or two varieties among our breeding progeny have shown considerable resistance to cold in the past, and perhaps in time a fairly resistant strain to cold or frost injury may be developed, but at present none of

the better known edible varieties can endure anything like freezing temperatures.

MOISTURE AND DROUGHT

Papaya plants will not withstand an excess of moisture or excessive drought conditions. They should be planted in well-drained soil and when in need, provided with the necessary water to promote normal growth. The plant is a vigorous grower and makes the most of its growth during the spring and summer months. During the dry periods of early spring, it will need a liberal supply of moisture to start its early growth off vigorously, and if this is lacking, the plant may become stunted, undersized, and of little value as a fruit producer.

NEMATODES

Nematodes frequently attack the roots of the papaya, and they may seriously injure the plant or cause its death. The injury is due to the attack of minute worms that infest a great many of our Florida soils and cause trouble to most vegetable crops. These tiny worms enter the roots of the papaya, causing knots to appear on the smaller roots and an enlarged, abnormal condition of the larger roots. They feed on the liquid taken up by the roots, preventing the plant from obtaining its normal supply of food. Affected plants may appear wilted or yellow and stunted in growth. Only a part of the root system may be involved, and the plant will continue on in a weakened condition for some time. Again, the entire root system may be so infested with nematodes as to cause the sudden death of the plant. Young plants will decline more quickly from nematode attacks than older bearing plants since the root system is smaller, more fragile, and it is easily invaded by the pests. As the development of the root system is retarded by their invasion, the plant ceases to grow, becomes weaker, and finally dies from lack of food material.

Large bearing plants that become slightly infested with nematodes in the later stages of growth may be carried through an attack and rejuvenated for a time by proper care.

CONTROL

There is very little to offer in the way of remedial measures after nematodes have once become well established in the roots or soil surrounding the plant. There are several precautions that might well be remembered, however, before the plants are set in the soil. The seed should be germinated in soil known to be absolutely free from nematodes. If the young seedlings are affected with the pest, there is very little chance of getting away from it.

When the seedlings are large enough to plant in the open, they should be transferred to a place where nematodes are not present. Old cultivated soils that have grown peppers, egg-plant, beans, and tomatoes for several years are not apt to be satisfactory for papaya plantings, since nematodes will be present in abundance, unless some treatment has been given to the soil for their eradication.

Dry weather seems to favor nematode infestation since it has a weakening effect on the plants.

As soon as the plants are set in the open, they should be well watered, properly fertilized, and kept under vigorous growing conditions to the end of the summer season. Plants that do not respond to this treatment have something wrong with them and should be removed from the field as soon as noticed.

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PALMS FOR FLORIDA LANDSCAPES

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While the bulk of the world's 1200 or more palms are tropical, quite a number are found in the warmer parts of the temperate zones. The five or six southernmost counties of our state are often claimed as belonging to the tropics—mostly for propaganda purposes—but those of us who are old-timers enough to remember the freeze of '17 as well as that of '34 know that this is not quite true. However this does not alter the fact that in this favored corner of the warm temperature zone we can and do grow a great many species that are really tropical, such as the coconut, the royals, the sugar-palms and the latanias among the palms. For the benefit of a chance Californian in the audience, I shall make this even stronger: some of these tropical denizens, such as

the Cuban royal palm and hundreds of other West Indian species, like our climate so well that they form the bulk of our "hammocks," or run wild along our shores, as does the coconut.

But since the other sixty-two counties that are, or should be, represented at this convention have never claimed to be anything more than warm, temperate, let us in this discussion consider only such species as can be grown throughout the larger part of the state. We will take them in alphabetical order.

Acoelorrhaphe (Paurotis) Wrightii, the Cuban Saw-palmetto.—A native fan palm, strongly resembling the upright form of the common saw-palmetto, except that its clustered 20-to-30-ft. trunks grow more uprightly and usually closer